APPENDIX B

MAINTENANCE PROGRAM

Maintenance Program

A maintenance program is necessary to ensure continued functionality, public safety, and effective stabilization of Calabazas Creek from Miller Avenue to the upstream study limit of the Comer Debris Basin property after new project at the time construction is complete and becomes operational.

This section outlines the Stream Maintenance Program (SMP) for Calabazas Creek. SMP is designed a program for conducting routine stream maintenance activities of the District. The SMP will provide for maintenance of the constructed project without necessity of obtaining individual permits each year. This maintenance program will be performed in accordance with the governing regulatory permits (Memorandum of Understanding [MOU], Streambed Alteration Permits with the California Department of Fish and Game, Section 404 of the Clean Water Act administered by the U.S. Army Corps of Engineers, Water Discharge Requirement and Water Quality Certification from California Regional Water Quality Control Board). Also the District will provide consistent reporting procedures to streamline and simplify annual reporting regarding long-term maintenance impacts and baseline condition evaluations to the regulatory agencies.

Maintenance activities for proposed modifications on Calabazas Creek will begin after completion of construction and will be performed under the Routine Maintenance Activities in the Improved Channel MOU. Maintenance activities have been, and will only be, performed on areas where the District has a right of way. Maintenance standards for removal of sediment and vegetation management activities on Calabazas Creek are included in Table B-2.

No person will do any modification within District Easement unless Encroachment Permit for Modification is obtained. Residents along Calabazas Creek who are responsible for creek maintenance on their property should use this program as a guide. Permits are required by District Ordinance 06-01 for any work done within the District's jurisdiction.

Maintenance Activities

The goals of the maintenance program include: restoring the channel to design conditions, repairing channel facilities as necessary, and eliminating hazardous conditions. The channel will be restored to design conditions by controlling woody growth in the creek channel and by removing accumulated debris and sediment. Channel protection and conveyance structures (bridges, culverts, rock revetment, live log slope protection, crib walls and rock cross vanes) will be repaired as necessary. Hazardous conditions will be eliminated by repairing and protecting eroding channel banks, protecting degrading channel bottom, and removing obstructions to flow, such as fallen trees and debris. District maintenance staffs will perform annual inspections to determine needed maintenance on Calabazas Creek.

Severe erosion that causes hazardous steep banks, loss of vegetation, and exposure of bare soil is environmentally damaging. The District will utilize appropriate measures to protect eroding channel banks. The District will also install rock cross vanes to stop excessive incision of the channel where required.

Sediment in the channel will be allowed to accumulate to an acceptable maintenance limit. When this limit is exceeded, the accumulated sediment would be considered an obstruction to flow and the channel will be restored to design conditions where the SMP permit allows. See Table B-2 for sediment limits.

Vegetation management activities in the channel (toe of bank to toe of bank) will be performed under District's jurisdiction. When the vegetation is considered an obstruction to flow or an impact of the flood conveyance capacity, the channel will be restored to design conditions. Between maintenance cycles vegetation will provide habitat value and shading. See Table B-2 for vegetation limits.

Obstructions to flow such as fallen trees and debris will be removed from the creek as allowed.

Maintenance activities within the channel will be scheduled to minimize adverse impacts to water quality, fish and wildlife resources and their habitat. Periods of concern are March through June for nesting birds, and October through March for fish.

Erosion Control

Soil erosion is a natural process which occurs both on the channel banks and bottom within the reaches of Calabazas Creek. As bank erosion occurs, vegetation is lost, soil is lost, property improvements may be threatened, and channel capacity may be compromised. As the creek bottom erodes, the channel becomes deeper and more incised, resulting in less stable banks with greater potential for bank erosion and failure. Increased soil erosion on the channel banks and bottom increases suspended sediment in the creek degrading aquatic habitat and water quality.

District maintenance staff monitors Calabazas Creek for developing erosion sites. Sites which are actively eroding will be subject to either (1) preventative slope protection, or (2) repair of failed slopes. Preventative slope protection will be implemented and monitored at sites where banks are vertical or undercut up to 8 feet vertically (See Figure B-2).

Preventative Slope Protection

Preventative slope protection consists of protecting the toe of the channel bank, thereby stabilizing the zone of highest erosion potential and, if necessary, protecting the channel bottom to stabilize degradation. Erosion sites will be repaired with the most appropriate techniques designed necessary by the engineers. Traditional methods of controlling erosion have relied on hardscape practices such as concrete blocks, gabions, and sacked concrete slope protection. However, these techniques have negative impacts on streams. Also these methods are expensive. Nowadays, bioengineered bank stabilization methods are widely applied in preventative slope protection such as boulder toe covered with vegetation, live log crib wall, bank surface matting and rock revetment. These bioengineered techniques involve the planting of native streamside or riparian vegetation combined with the strategic placement of live logs or minimal rocks (See Figure B-3). The natural attributes of plants, when combined with stabilized bank slopes, provide better dynamic stream systems than stationary hard structures.

Rock cross vanes will be installed to prevent any further degradation (Figures B-3 and B-4) if active channel bottom degradation is observed. All alluvial streams scour during flood events unless the bed is armored with large material. Bank instability and erosion may, in some cases, be directly correlated to increased bank height due to channel bottom degradation.

Rock cross vanes will be constructed with large boulders 4 to 5 feet in diameter and be laid in an arch-shape, with the closed end of the arch facing upstream. This forms a vortex that creates a downstream plunge pool for energy dissipation and aquatic habitat. A low flow channel will be incorporated into the rock cross vane. The sizes of the boulders are designed so that they will not move by any expected flow velocity. Rock cross vanes will be limited to approximately two feet in height above the channel bottom. Multiple weirs will be installed and spaced appropriately to stabilize the channel.

Remedial Slope Protection

Alternatives for remedial slope protection can be divided into two categories: live construction and mixed construction constructions. Live construction consists of using grasses or live plantings. Mixed construction consists of structural methods using plant materials combined with armoring materials (rock revetment, root wads and boulders, cribwalls, etc.). A criterion for conditions under which each method is appropriate is outlined below and will be used in planning erosion protection projects to minimize adverse environmental impacts.

The objective when selecting an erosion protection method is to meet engineering requirements and provide the greatest biological enhancement with the least amount of negative impacts. Engineering requirements involve the physical ability of the material to provide reliable structural support within the site constraints. This includes the ability of the material to provide lateral support to the bank as well as sustained protection against erosive velocities. Biological enhancement considers the ability of the method to provide opportunity for natural re-vegetation. Once erosion on the earth channel has occurred, the site constraints determined, cause of erosion determined, and ecological setting evaluated, the erosion protection method and material will be considered and selected. The methods and materials available for remedial slope protection will be evaluated for consideration in the order given below. A summary of the remedial slope protection methods is shown in Table B-1 at the end of this section.

Live Construction

Live construction consists of traditional methods of planting grasses and plants to control erosion. Vegetation planting methods typically used are cuttings, transplants, live staking, and direct seeding (including hydro-seeding). Plants are chosen to tolerate drought conditions. Biodegradable erosion control material is frequently used in combination with live construction to assist in plant establishment.

This type of erosion control provides good re-vegetation potential, but is only effective where bank slopes are 2:1 or flatter and for local channel velocities of 6 feet per second or less.

Mixed Construction

The District utilizes innovative technologies (where appropriate) to repair creek bank erosion. Mixed construction combines structural methods using both plant and inert materials. Sub-categories of Mixed Construction are Soil Bioengineering and Biotechnical Slope Protection.

Soil Bioengineering

Soil Bioengineering refers to the use of plants and plant parts to control soil erosion. Live cuttings and plant parts are imbedded and arranged so that they act as soil reinforcements, hydraulic drains, or barriers to earth movement. Methods included in this subcategory include contour wattling, brush layering, and bank surface matting. While the root systems of these components can increase the "structural integrity" of a stream bank with time, their initial value is in protecting the bank surface.

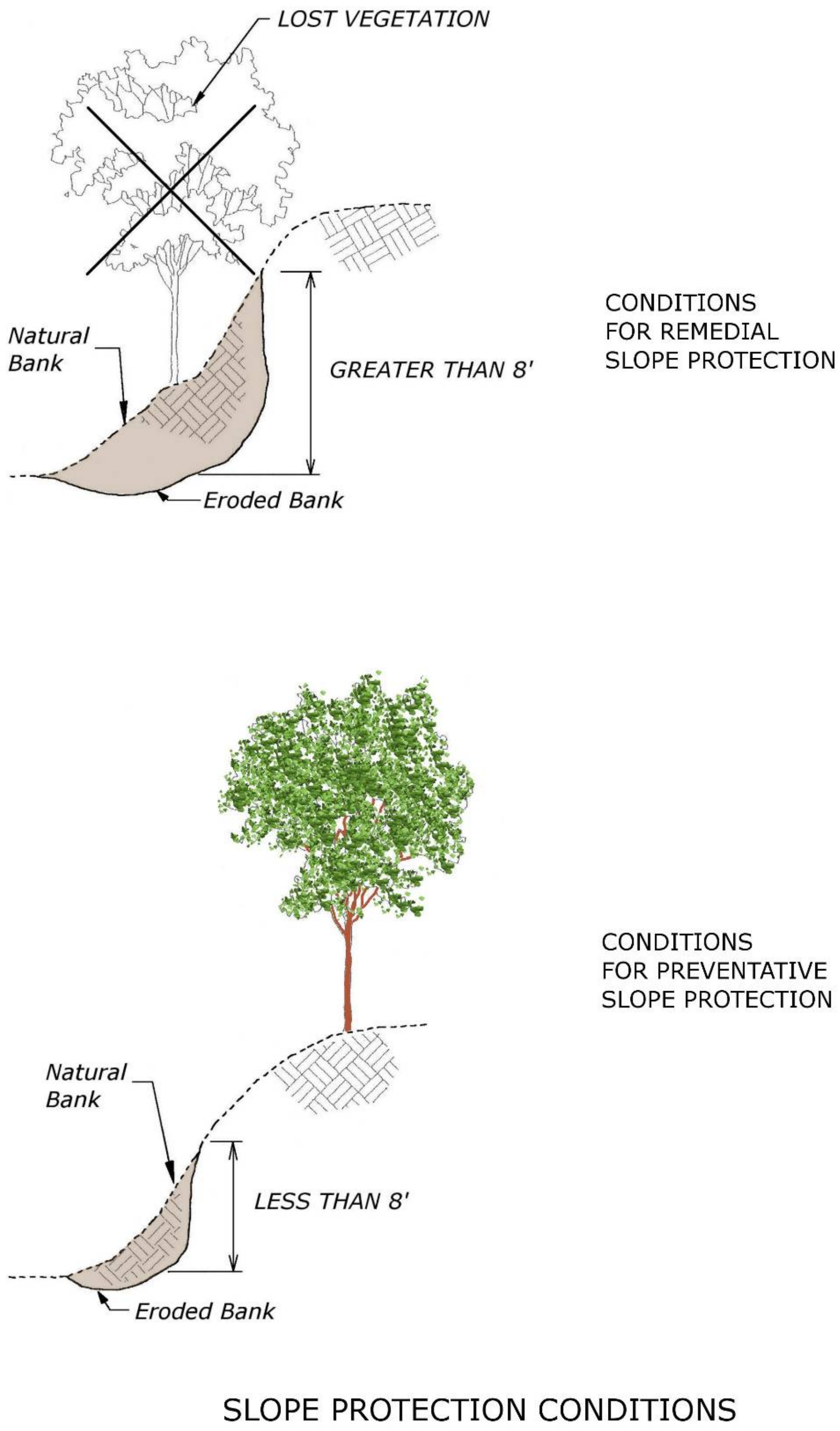
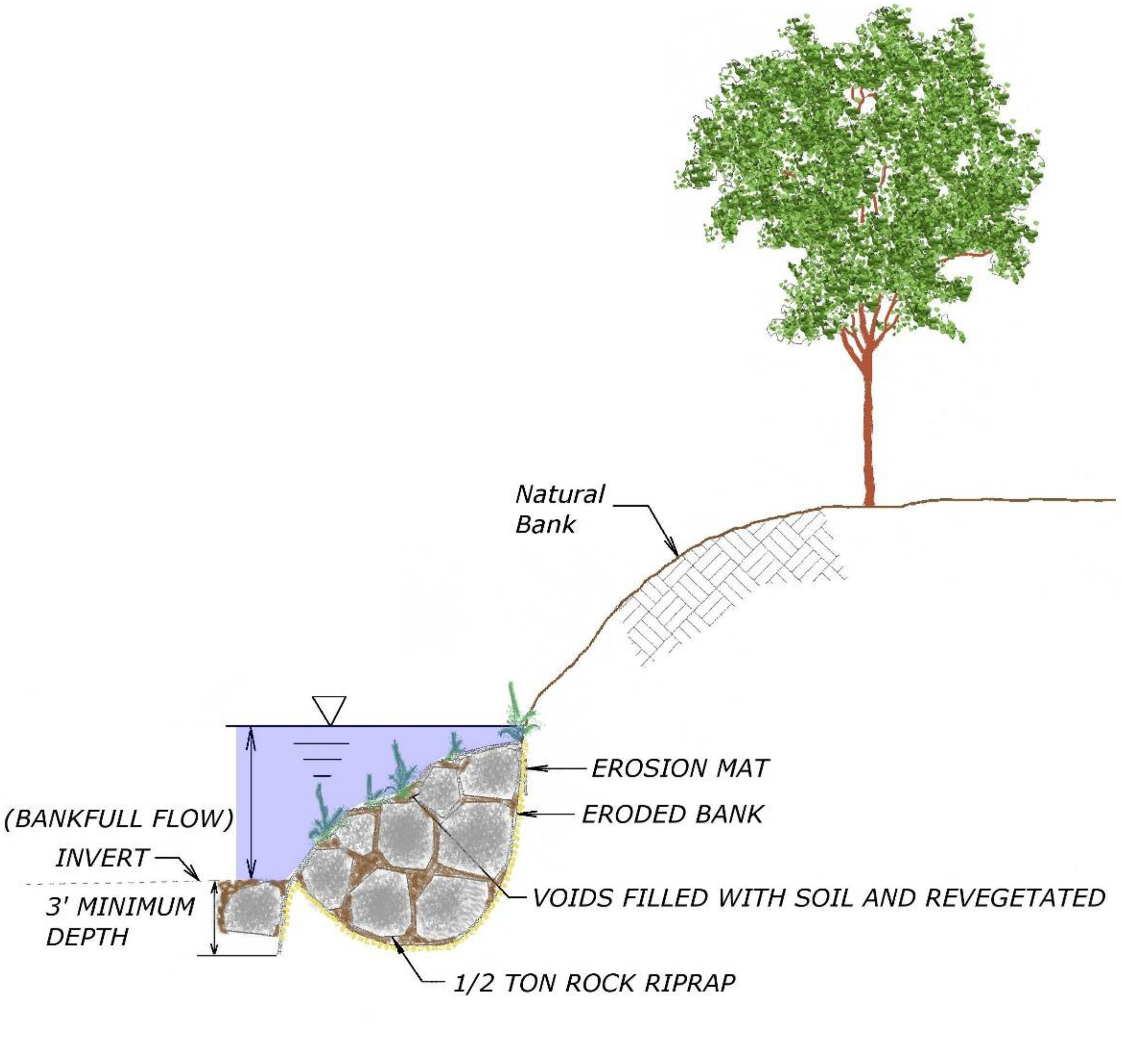

LOST VEGETATION
Natural Bank
GREATER THAN 8'
Eroded Bank
CONDITIONS FOR REMEDIAL SLOPE PROTECTION
CONDITIONS FOR PREVENTATIVE SLOPE PROTECTION
Natural Bank
LESS THAN 8'
Eroded Bank
SLOPE PROTECTION CONDITIONS

Figure B-1 Slope Protection Conditions



PREVENTATIVE EROSION SOLUTION

Figure B-2 Preventative Erosion Solution

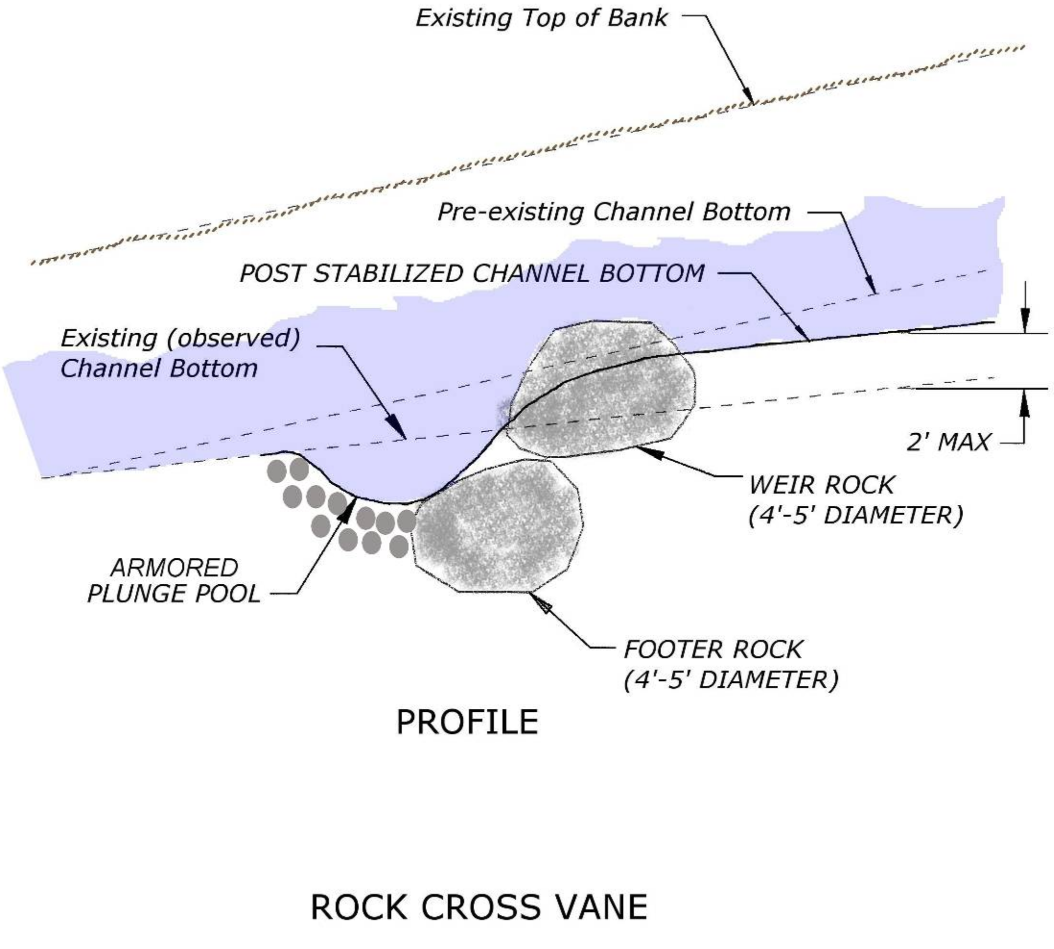
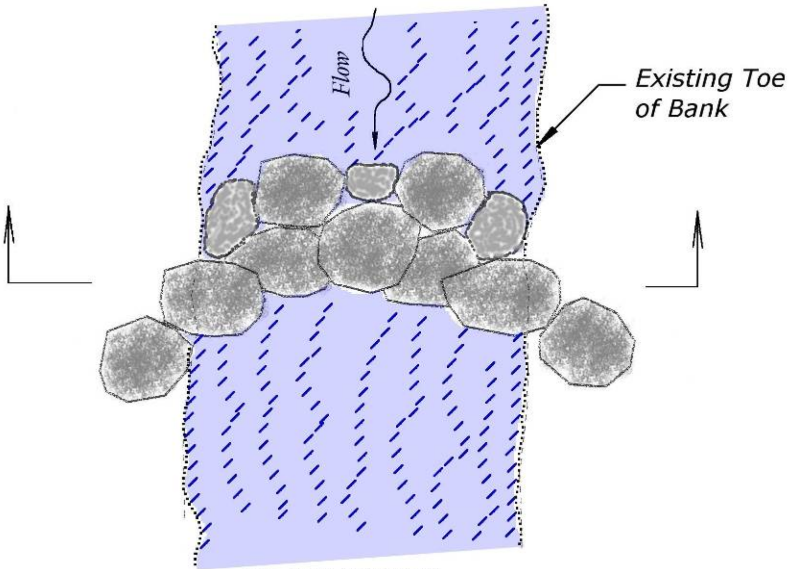
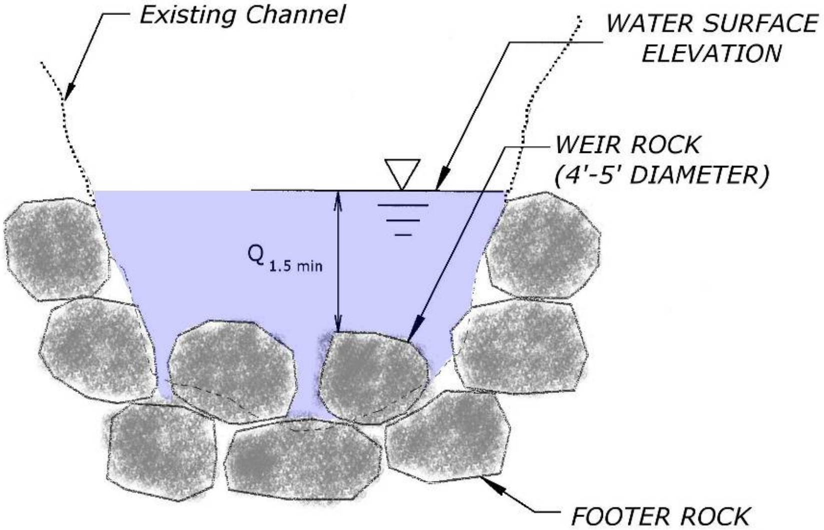

Existing Top of Bank
Pre-existing Channel Bottom
POST STABILIZED CHANNEL BOTTOM
Existing (observed) Channel Bottom
2' MAX
WEIR ROCK (4'-5' DIAMETER)
ARMORED PLUNGE POOL
FOOTER ROCK (4'-5' DIAMETER)
PROFILE
ROCK CROSS VANE

Figure B-3 Rock Cross Vane (Profile View)



PLAN VIEW



CROSS SECTION

ROCK CROSS VANE

Figure B-4 Rock Cross Vane (Plan & Section View)

-*Contour Wattling*

Contour wattling consists of long bundles of plant stems tied together with twine and anchored in shallow trenches with wooden stakes (Figure B-5). When the stems develop root systems and mature, the plant (typically willows) establishes structural stabilization properties within the soil root structure. Protection from erosive flow velocities result from the protective armoring quality provided by the plant's stems and leaves.

This method, like live construction, provides good re-vegetation potential, but only applies to situations where bank slopes are 2:1 or flatter and local channel velocities 6 feet per second or less. Most of the study reach has flow velocities greater than 6 feet per second, therefore contour wattling will only be implemented on a limited basis.

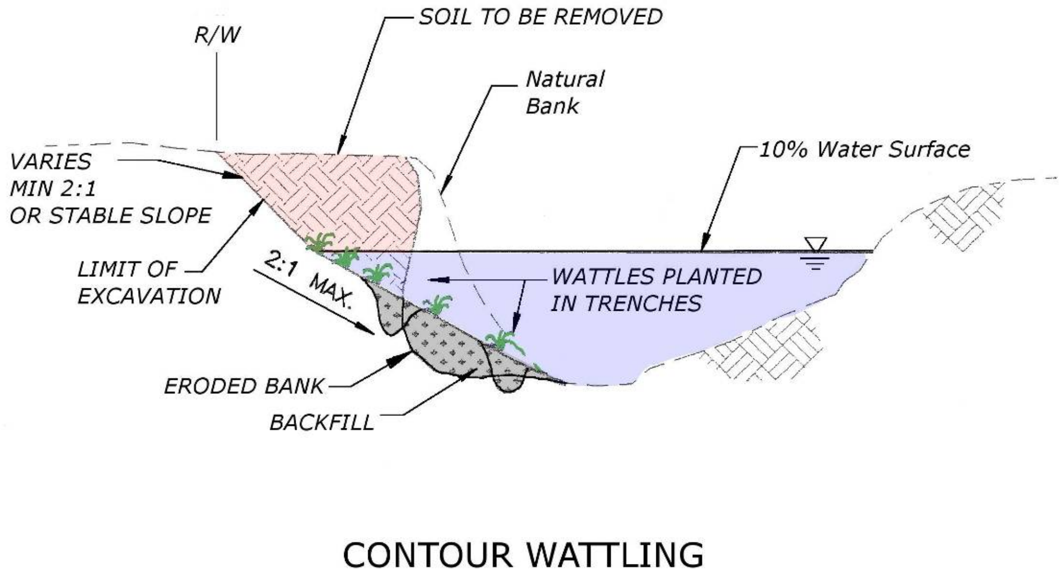


Figure B-5 Contour Wattling

-*Brush Layering*

Brush layering consists of placing live cut branches on the bank and covering them with a lightly compacted layer of soil (Figure B-6). The tips of the branches extend out of the bank, thus slowing down overbank flow and trapping bank sediment. After the branches take root along their length, they begin to act like horizontal slope drains on the bank.

This method, like live construction, provides good re-vegetation potential, but applies to situations where bank slopes are 2:1 or flatter, and for relatively low velocities up to 6 feet per second or less.

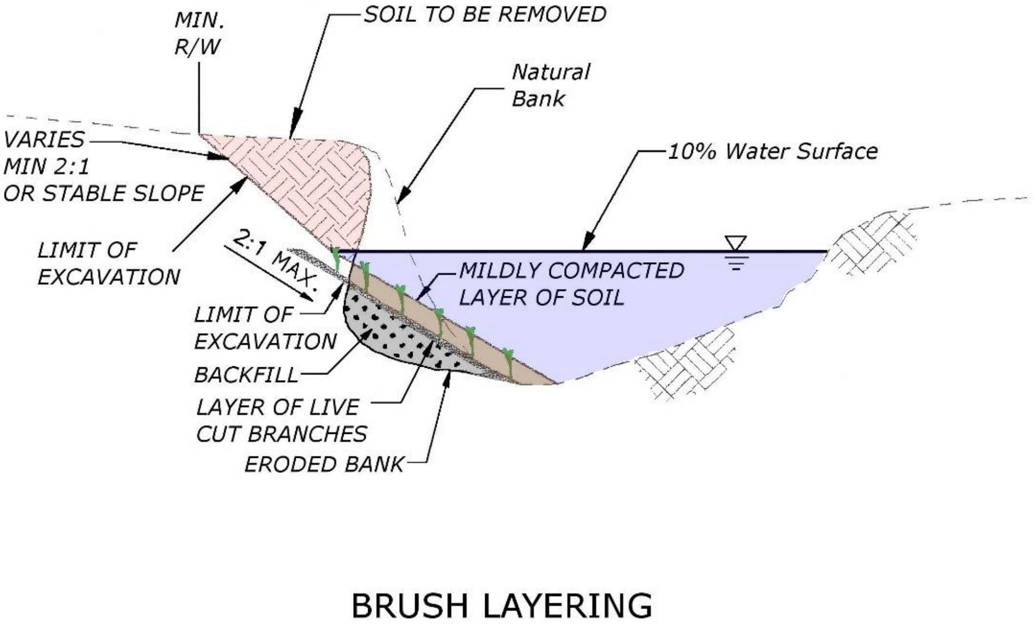


Figure B-6 Brush Layering

-*Bank Surface Matting (Erosion Mats)*

Bank surface matting (erosion mats) consists of securing plastic, jute, or geotextile fabric surface liners to channel banks using stakes or staples (Figure B-7). These materials provide soft armor protection against erosive velocities and are combined with live staking or direct seeding. Abrasive sediments and debris will wear, snag, and tear these fabrics with time, potentially undermining the structure. They work best in uniform improved channels with flat bank slopes. Similar to contour wattling, their application is limited to bank slopes of 2:1 or flatter, and local channel velocities of 7 feet per second or less. This method has good re-vegetation potential.

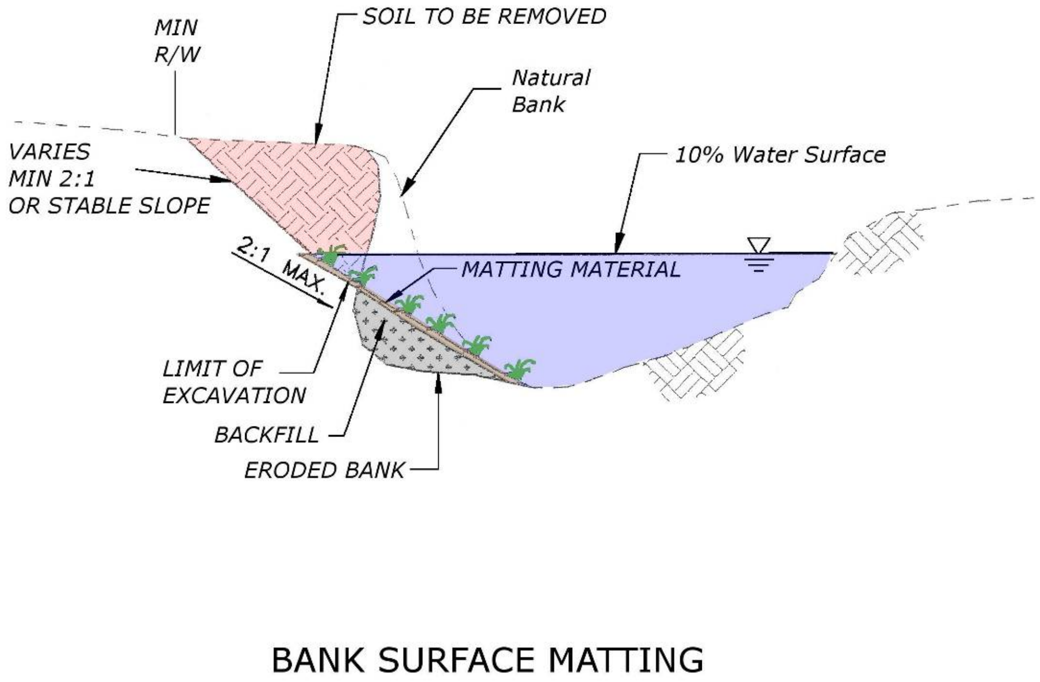


Figure B-7 Bank Surface Matting

Biotechnical Slope Protection

Biotechnical Slope Protection combines live vegetation with armoring (inert) material to control erosion. Any armoring material that has voids can lend itself to Mixed Construction by planting within the voids.

-***Root Wads and Boulders***

The root wads and boulders repair method consists of placing tree root wads and interspersed boulders in eroding bends of the creek (Figures B-8 and B-9). The root wads are placed pointing upstream and the boulders (4 to 5 feet in diameter) are placed in between the wads to hold them in place and set the spacing between them. In addition to the boulders, a footer log is used to support the root wad from below and another log is placed over the root wad to hold it from above. The root wads used will have a minimum of 10 feet of tree trunk or bole still attached to the root, with a minimum of 80 percent of the length buried into the creek bank. This tree trunk offers anchoring against movement to the repair. After the root wads, boulders, and supporting logs are put in place, soil is placed on top, sloped back, and live staked.

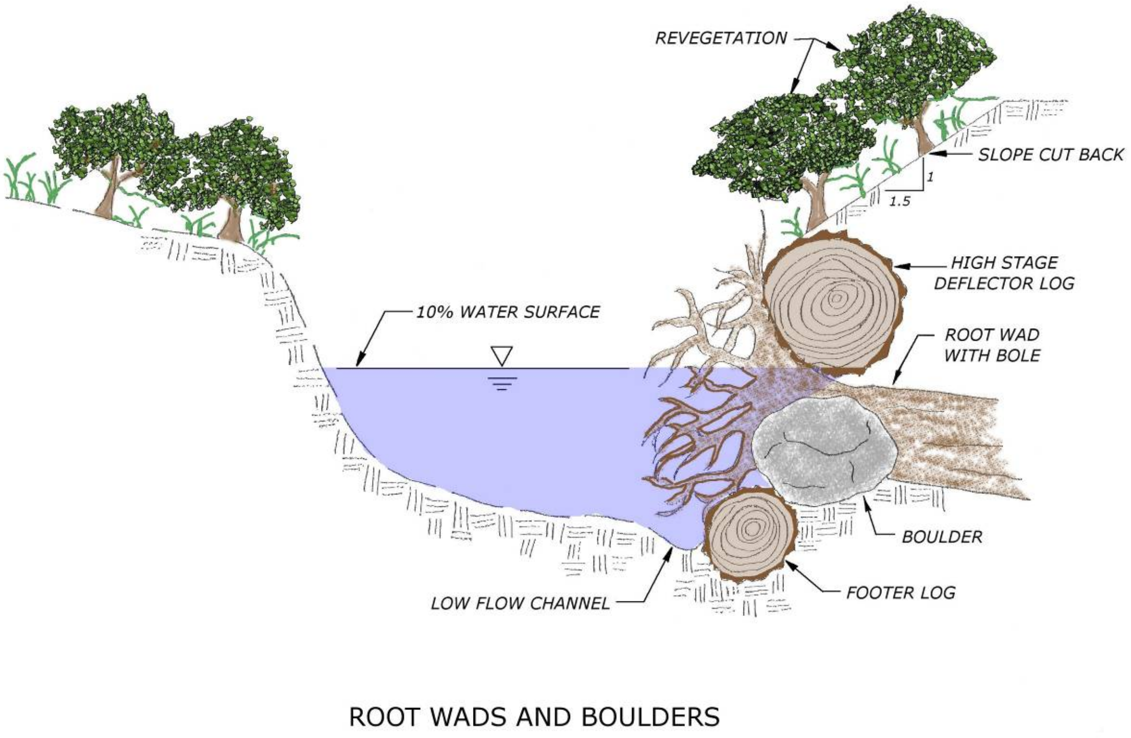


Figure B-8 Root Wads and Boulders

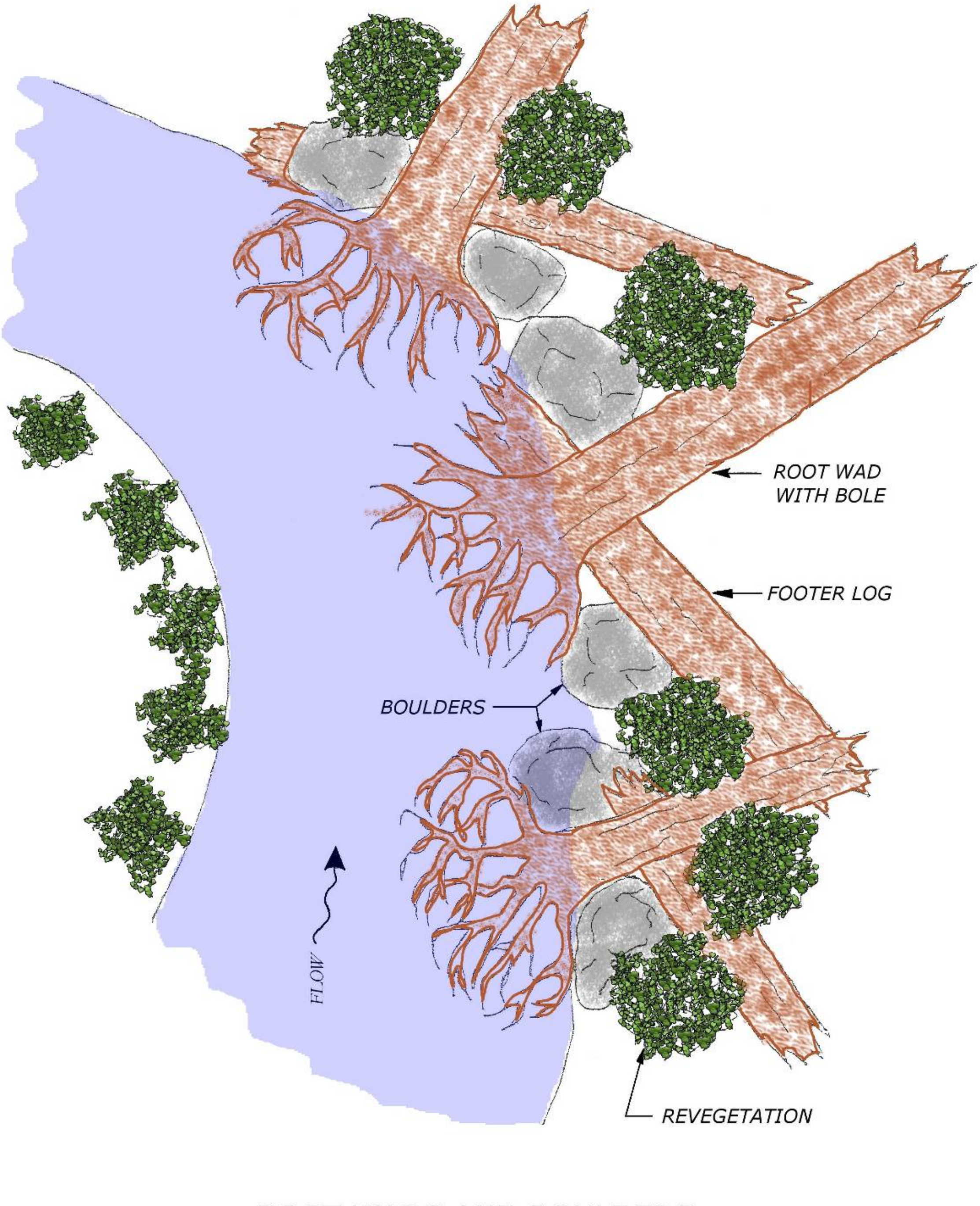


Figure B-9 Root Wads and Boulders (Plan View)

This method requires approximately 20 feet of depth horizontally into the bank for installation. Straight sections and narrow bends of Calabazas Creek would not have enough area for installation. When installed correctly, this method can be applied where channel velocities are 10 feet per second or less. The longevity of this method is also governed by the type of trees that are used and the amount of time during the year that they are wet. The maximum decay rate occurs with alternate wetting and drying, or consistently damp conditions. It is unlikely that deciduous woods can be relied on to survive for more than 5 or 10 years. Sufficient anchoring boulders are placed over the root wads such that as the wood decays the boulders can settle and maintain the structural integrity of the embankment.

-***Soil Cellular Confinement System***

Soil Cellular Confinement System (GEOCELL) is a polyethylene plastic cellular system where structural strength is developed by the composite design of soil, plant roots, and the plastic cellular configuration (Figure B-10). This system is available in 8-inch deep honeycomb mats that are installed in offset vertical layers to create terraced planting areas. The honeycomb terrace cells are filled with soil which is moderately compacted and planted with woody and herbaceous vegetation to augment structural qualities. This structure functions similar to a crib wall structure.

This material has been used to repair a variety of erosion problems ranging from slopes flatter than 2:1 with velocities less than 6 feet per second, to structural designs on steep slopes (up to ½ : 1) experiencing velocities greater than 6 feet per second. This method has good re-vegetation potential, but not as good as Live Construction or Soil Bioengineering methods.

-***Rock Revetment***

Erosion is eliminated at the toe and on the bank slope by placing rock on the bank (Figure B-11). Rock sizes can vary from 6 inches to 4 feet in diameter. This method applies to slopes that are 1 ½ :1 or flatter and flow velocities up to 15 feet per second.

Rock selected will be sufficiently large and uniform to enable soil to be placed between the rocks and planted by live staking or direct seeding. A biodegradable erosion mat may be used over the rock to establish vegetation depending on creek conditions at the location of the repair. Angular rock will be used because it tends to interlock making it more stable, which makes the revetment act like a single structure rather than a collection of independent stones. One advantage of a rock system is flexibility because it can settle and conform to the final streambed contour if scour occurs. Rocks also create habitat by providing refuge for fish from high-flow velocities and creating scour holes.

This method has good re-vegetation potential, but slightly less than Soil Cellular Confinement System.

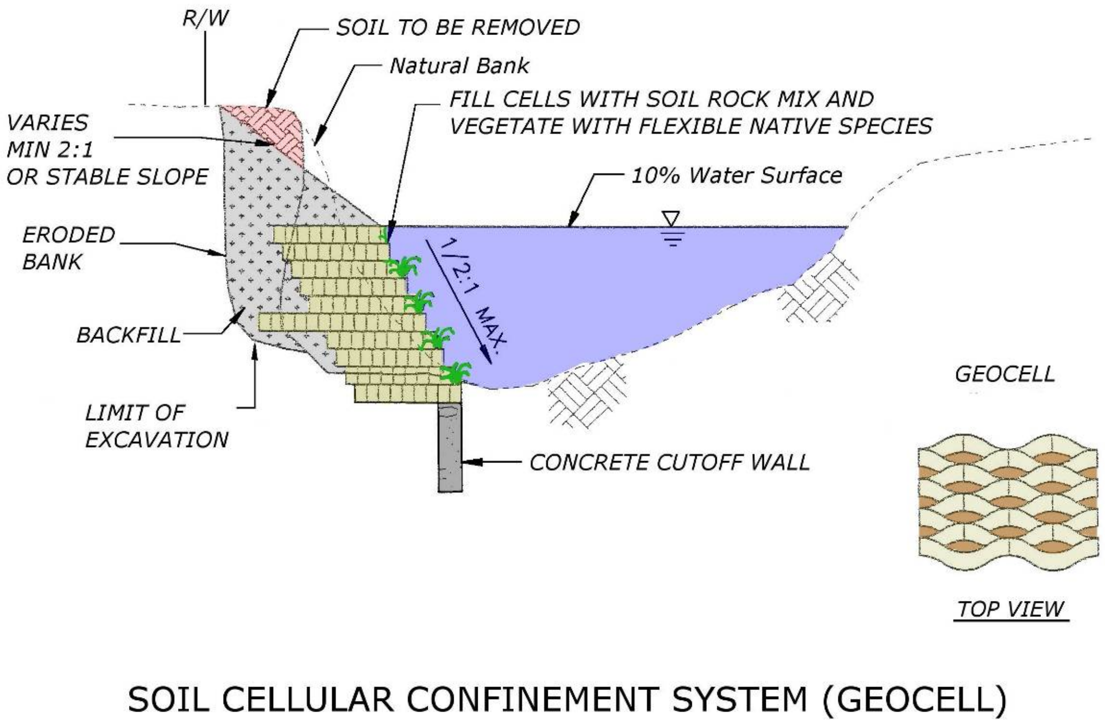

R/W
SOIL TO BE REMOVED
Natural Bank
FILL CELLS WITH SOIL ROCK MIX AND VEGETATE WITH FLEXIBLE NATIVE SPECIES
VARIES MIN 2:1 OR STABLE SLOPE
10% Water Surface
ERODED BANK
1/2:1 MAX.
BACKFILL
LIMIT OF EXCAVATION
CONCRETE CUTOFF WALL
GEOCELL
TOP VIEW
SOIL CELLULAR CONFINEMENT SYSTEM (GEOCELL)

Figure B-10 Soil Cellular Confinement System (GEOCELL)

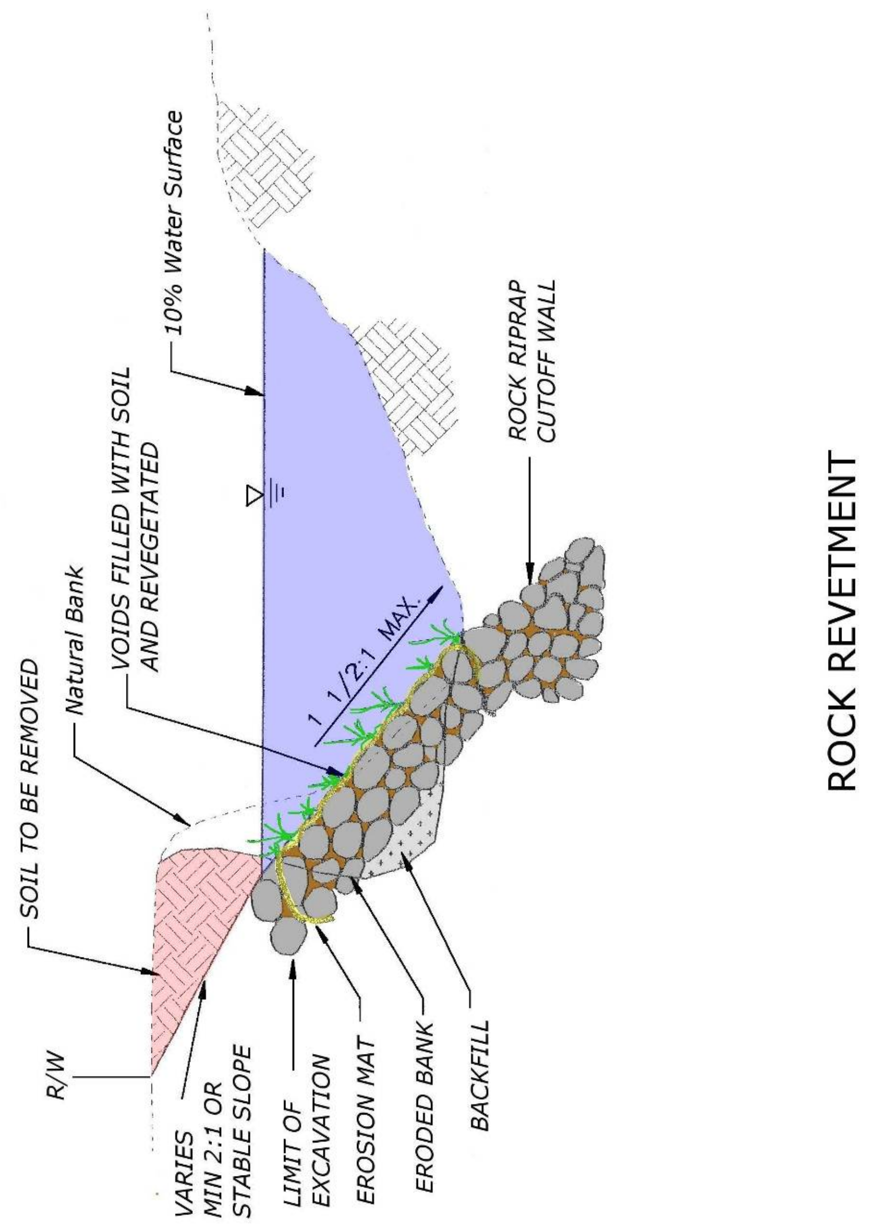


Figure B-11 Rock Revetment

-*Log Crib Walls*

Log Crib walls consist of stacked interlocking timber frames that form a retaining wall (Figure B-12). The structural strength is developed by the composite design of a timber frame with compacted backfill. Live Log Crib walls can be sloped up to ¼:1 and can withstand velocities up to 15 feet per second. Live Log Crib walls can be constructed with open face panels that are planted by live staking. Like articulated concrete block (ACB), crib walls restrict plant growth to the size of the panel opening, therefore re-vegetation is limited.

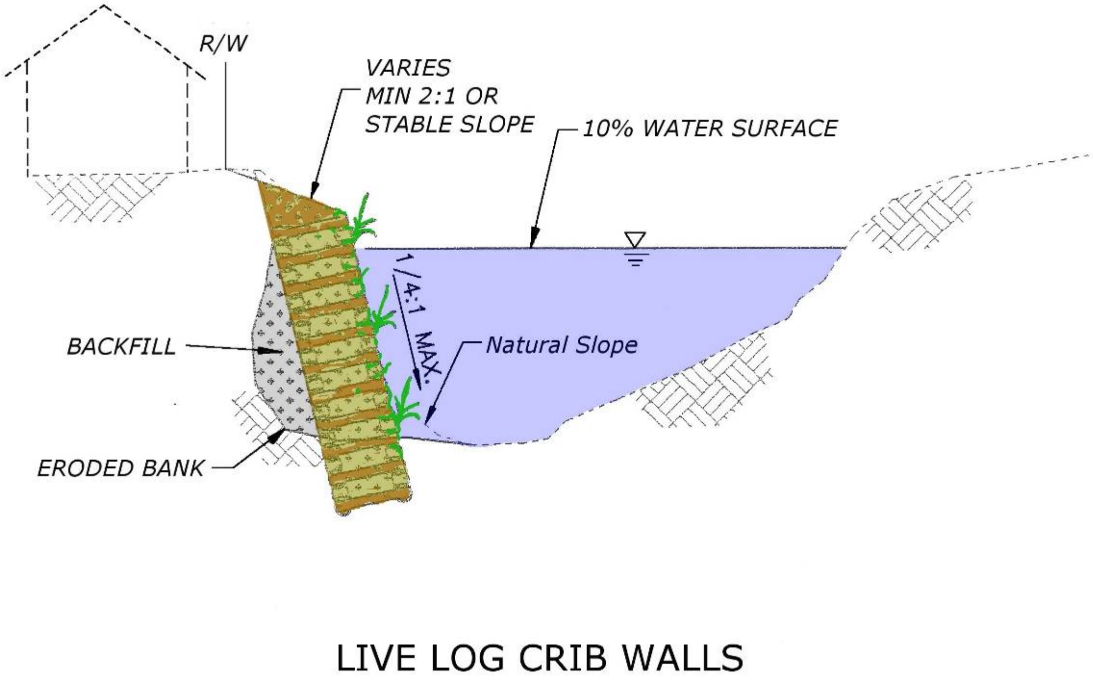
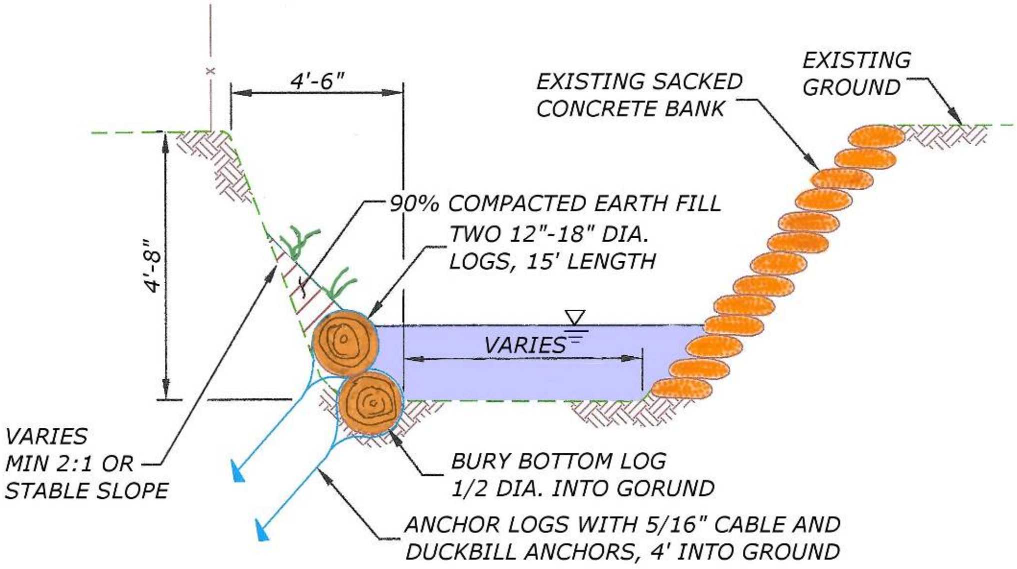


Figure B-12 Log Crib Wall

Live Log Toe Protection Covered with Vegetation

Live Log Toe Protection consists of two 12-inches in (up to 18 inches) diameter, 15 feet long, stacked live logs positioned in front of the excavated trench parallel to the toe of slope (Figure B-13). Approximately 50 % of the bottom log is buried into the trench. The logs are anchored with 5/16" cable. The ends of the logs are cut at 45 degree into bank to deflect stream flows. Backfill compacted to 90 % is placed over the logs at slope 2:1 of flatter. Vegetation is installed by staking and or direct seeding. This technique can withstand velocities up to 15 feet per seconds.



4'-6"
EXISTING SACKED CONCRETE BANK
EXISTING GROUND
4'-8"
90% COMPACTED EARTH FILL
TWO 12"-18" DIA. LOGS, 15' LENGTH
VARIES
VARIES MIN 2:1 OR STABLE SLOPE
BURY BOTTOM LOG 1/2 DIA. INTO GORUND
ANCHOR LOGS WITH 5/16" CABLE AND DUCKBILL ANCHORS, 4' INTO GROUND

LIVE LOG TOE PROTECTION

Figure B-13 Live Log Toe Protection Covered with Vegetation

A summary of all of the remedial slope protection methods is shown in Table B-1. Rock cross vanes will also be installed as a remedial slope protection measure if channel degradation is causing bank erosion or if channel degradation threatens existing channel structures, existing erosion protection, or adjacent private improvements. Rock cross vanes will be constructed as described in the Preventative Slope Protection section (see Figures B-3 and B-4). Rock cross vanes construction will be considered as an alternative to bank slope protection or will be installed, where needed, in conjunction with slope protection.

Both channel bank and bottom protection need to be designed for each specific site. Examples of details that will be designed are (but are not limited to): appropriate repair method, size of rock, thickness of rock, depth and configuration of footings or trench, planting and native species.

When possible, slope protection will be installed without excavating into the existing eroding bank. Slope protection will match the upstream and downstream channel section by reestablishing the pre-erosion bank slope. This practice will minimize impacts to existing vegetation and prevent erosion downstream. Proposed slope protection will be placed up to the 10 percent water surface elevation unless it is done as a preventative measure. Slope protection can be placed above the 10 percent water surface elevation if the existing site conditions warrant it. An example of this situation would be a big redwood tree located at the top of the creek bank. The protection height will be determined on a case-by-case basis by District maintenance personnel.

If the selected slope protection method requires more space with grading to accommodate a stable slope, one of the two following construction approaches can be applied: (1) excavate into the existing bank, or (2) move the center of the channel farther away from the eroding bank.

1. A 2:1 minimum slope will be excavated back from the top of the slope protection where the District has ample right of way and no valuable native vegetation will be impacted (Figure B-14). This procedure will establish a stable slope above the 10 percent water surface and will allow the District to replant native vegetation on the upper bank.

   A slope will not be excavated from the top of the slope protection where there is either insufficient right of way, structures, or valuable native vegetation that would be impacted (Figure B-15). This approach protects the lower bank from further erosion, but allows the upper bank to find its own stable condition naturally without disturbing existing conditions.

2. If a point bar has developed on the bank opposite the eroded bank, then it could be excavated to reestablish a channel alignment that is closer to the opposite bank (Figure B-16). Available right of way and existing vegetation would also need to be evaluated for this approach.

The channel bottom will not be narrowed beyond the existing upstream and downstream conditions. Narrowing the channel could cause channel bottom degradation, downstream erosion, and increased upstream water surface. If neither of the two above alternatives can be applied, another slope protection method will be considered.

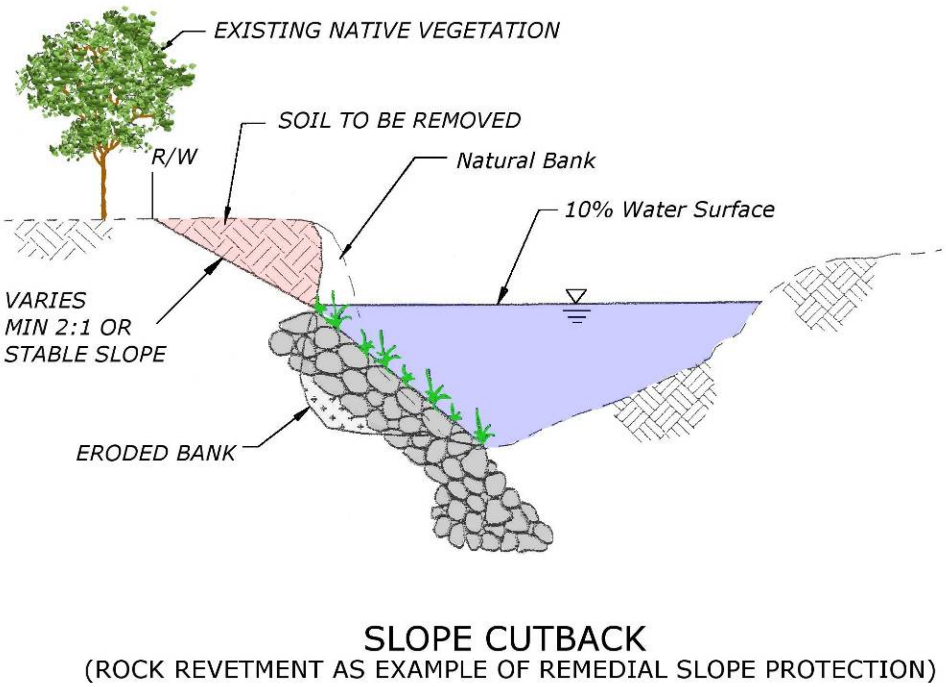


Figure B-14 Slope Cutback

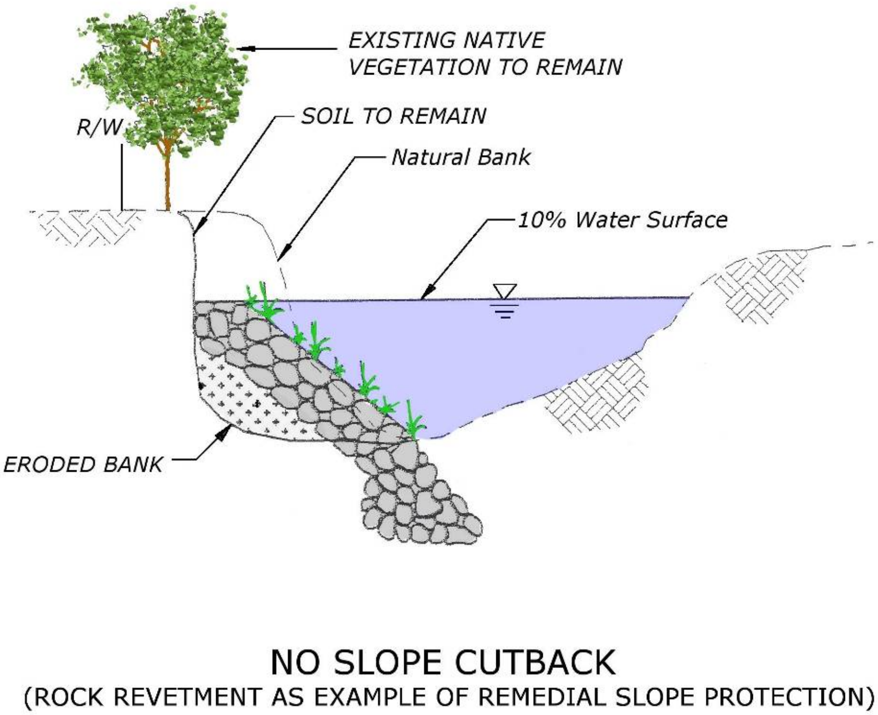


Figure B-15 No Slope Cutback

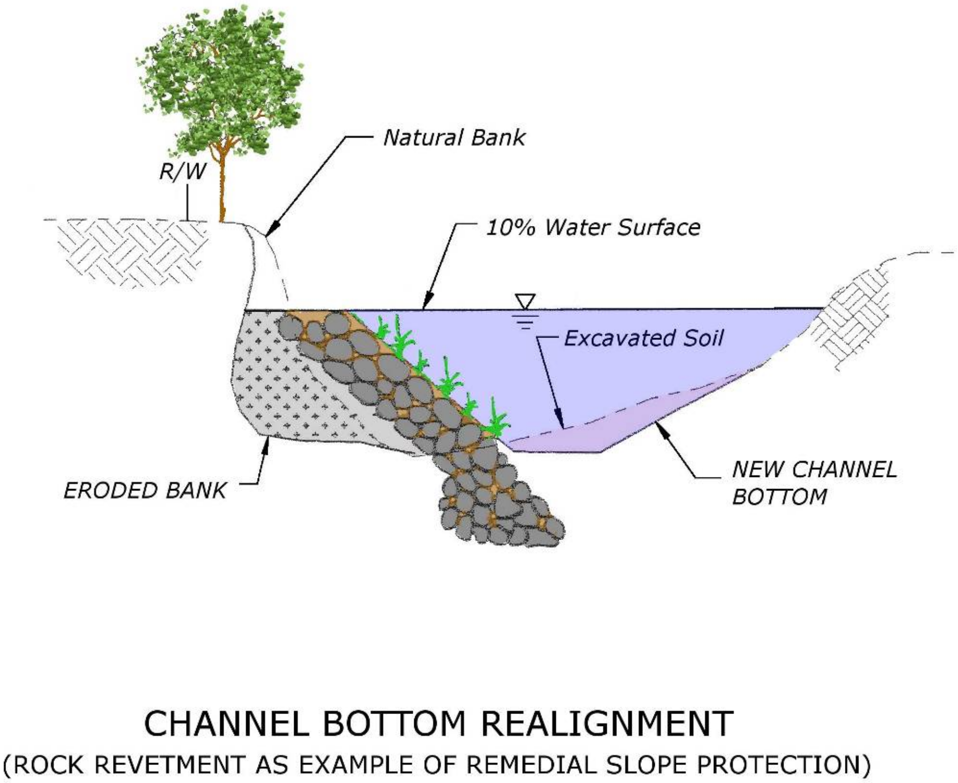

Natural Bank
R/W
10% Water Surface
Excavated Soil
ERODED BANK
NEW CHANNEL
BOTTOM
CHANNEL BOTTOM REALIGNMENT
(ROCK REVETMENT AS EXAMPLE OF REMEDIAL SLOPE PROTECTION)

Figure B-16 Channel Bottom Realigment

Erosion protection measures protect for a finite period of time before deteriorating. Therefore, the District will repair existing erosion protection as necessary. If existing erosion protection completely fails, the District will reevaluate the site for alternative methods of protection before reconstruction.

Vegetation and Sediment Removal

Vegetation and sediment will be removed only if they cause an obstruction to flow. Whether the obstruction is due to vegetation, sediment, or debris, removal is initiated upon recognition that the channel capacity is compromised.

In the modified channel sections , Miller Avenue to Comer Drive, vegetation may be removed by hand labor, mechanical means, and/or aquatic herbicides to the design height above the channel (see Maintenance Standards, Table B-2). All Aquatic Herbicides used have been approved by California Department of Pesticide Regulations (formerly CAL EPA) and are applied by a state licensed vegetation technician.

In the vicinity of hydraulic structures, obstructions to flow such as accumulated vegetation, sediment, and debris will be removed. Hydraulic features include bridges, culverts, outfall structures, bypass structures, and drop structures.

When it is necessary to take maintenance vehicles into modified channels, the drop structures will be covered with gravel to allow passage of vehicles without damage to the structure or the vehicle. This gravel will be removed at the conclusion of the maintenance activities.

Fallen trees and debris obstructing flow will be removed along Calabazas Creek as necessary where the District has right of way. Vegetation on maintenance roads and ramps will be controlled by hand labor, herbicides, or mechanical means.

Maintenance Activities Outlined By Reach

The following are maintenance activities, in addition to the above activities, that are specific to certain sections of Calabazas Creek: Reaches 26 to 33 (Miller Avenue to Comer).

Annual maintenance activities may include removal of large debris and fallen trees obstructing flow and construction and repair of erosion protection measures.

Periodic maintenance activities may include removal of vegetation and sediment in the waterway as described in the Maintenance Standards, Table 3.4. Concrete structures from upstream of Miller Avenue to Comer Drive will be inspected for abrasion and restored as necessary. Structural repair practices are outlined in Table 3.4. Channel access will be from ramps located at Miller, Rainbow, Blaney, and Prospect located on District-owned property adjacent to Calabazas Creek.

Only noninvasive erosion repair methods (no excavation) will be used in all Reaches as per resident request.

Maintenance Standards

Acceptable maintenance limits are based on Calabazas Creek design conditions. For modified creek sections, maximum levels of sediment and vegetation will be allowed within the flow area as long as the 1% storm design capacity is not exceeded. For unmodified creek sections or sections without proposed modifications, maximum levels of sediment and vegetation will be allowed within the flow area as long as it does not obstruct flow or prohibit the creek from being self-cleaning. These maximum levels are called acceptable maintenance limits and are listed in Table B-2.

Table B-1 Summary of Remedial Slope Protection Methods

Erosion Control Technique				
Category	**Method**	**Slope Requirements**	**Flow Velocity Requirements**	**Additional Information**
Live construction	Planting Grasses, Cuttings, Transplants, Live Staking, Direct Seeding	3:1 or flatter	4 fps* or less	Not feasible on Calabazas Creek due to excessive channel velocities. Use on slope above 1.5-year water surface.
Mixed construction-soil bioengineering	Contour Wattling	3:1 or flatter	6 fps or less	Plant roots protect soil. Creates benches or terraces (flat areas along bank). Limited use due to high creek velocities. Use on slope above 1.5-year water surface.
	Brush Layering	3:1 or flatter	6 fps or less	Similar uses and restrictions to contour wattling. Requires large quantity of material.
	Bank Surface Matting	3:1 or flatter	12 fps or less	May be combined with live staking or direct seeding. Erosion matting is used to provide structure for plant growth. Requires maintenance and replanting to measure performance. Similar uses and restrictions to contour wattling. Best onuniform channel slopes.
Mixed construction-biotechnical slope protection	Root Wads and Boulders	Varies	10 fps or less	For use on the outside of eroding bends. Approximately 20 feet of horizontal depth into bank is needed for installation.
	Soil Cellular Confinement system (GEOCELL)	~½ :1 or flatter	6 fps or less	Cells are filled with soil and planted with vegetation. Matrix is not biodegradable.

Table B-1 Summary of Remedial Slope Protection Methods (Continued)

Erosion Control Technique				
Category	**Method**	**Slope Requirements**	**Flow Velocity Requirements**	**Additional Information**
Mixed construction-biotechnical slope protection	Rock Revetment (Mild Slope Protection)	~2 :1 or flatter	15 fps or less	May be used for preventative as well as remedial protection. May be combined with live staking or direct seeding.
	Log Crib Walls	¾ :1 or flatter	15 fps or less	Crib walls restrict plant growth due to size of openings. Use soil bioengineering above crib wall.
	Log Toe Protection	~2 :1 or flatter	15 fps or less	May be used for preventative as well as remedial protection. May be combined with live staking or direct seeding.
	Log Mattress Protection	~½ :1 or flatter	15 fps or less	May be used for preventative as well as remedial protection. May be combined with live staking or direct seeding.

fps = feet per second local velocities, if unknown use 1.5 average velocity

Table B-2 Calabazas Creek- Miller to End of Project
Maintenance Standards for Vegetation and Sediment Removal

Facility	Maintenance Issue	Acceptable Maintenance Limit	Performance Criteria
Reaches 26 Through 33: Miller Avenue to Comer			
Modified Channel	Sediment accumulation	3.0-foot sediment depth	Remove sediment from channel bottom
Culverts	Concrete surface abrasion	Abrasion of 2 inches	Resurface
	Sediment accumulation	1.5-foot sediment depth	Remove sedimentation
All	Vegetation on roads or ramps	Present	Remove by mechanical means and aquatic herbicides to edge of road or ramp
	Vegetation overhanging roads or ramps	Present	Cut back overhanging vegetation to edge of road or ramp to a height of 12 feet
	Obstructions to flow	Present	Remove fallen trees and debris